

Learning analytics to predict student achievement in online learning during Covid-19 mitigation

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Abstract--- *This study aims to make predictions of online learning during the COVID-19 mitigation period by using Analytic Learning Techniques. Learning is done using Moodle as the learning management system. The primary statistical technique used in this study is cluster analysis, which groups students in three different characteristics based on the activity components. The results of the study indicate that the activity components that support social presence are the determining components in predicting learning success. Another consequence is that the three clusters formed can be identified as high, medium, and low groups in progress with the identifier of activity components. Chatting, Forum, Choice, and Assignment are the practical activity components in this finding. The result of this study is too early to state that the e-learning is successful during COVID-19 mitigation. More information is still needed for further analysis.*

Keywords--- *Learning analytics, Covid-19 mitigation, Online learning, Social presence*

I. INTRODUCTION

Internet-based ICT opens up many opportunities in the educational world in the recent decade. It is a very substantial role. It is evident during the Covid-19 mitigation period. Its massive utilization is also carried out by the Indonesian government through various instructions issued by the MOEC of Indonesia. It did since the WHO declared Covid-19 as a pandemic. MOEC encourages learning that was previously done face-to-face on campus to be transformed into online learning at which students entirely learn from home. Different levels of online learning technology readiness of each of the lecturers will certainly result in a different response to online learning processes. In other words, one lecturer will be different from other lecturers in the selection of learning management systems, learning strategies, and evaluation techniques.

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Indonesia is a country with relatively good availability of internet infrastructure and a growing internet penetration rate. This will be a support of the transformation process of the learning environment. In the higher education level, several LMSs are immediately installed to provide good service in this online learning process. One LMS that is relatively widely used is Moodle. Through this LMS, lecturers, and students try to learn independently using and understanding the existing features. All these aspects are to be used, and the results are to ensure effective learning in achieving learning objectives.

Several studies are showing that social presence is an important factor in the success of online learning. Social presence is the ability of lecturers and students to project their personal characteristics into the online community. The lecturers and students really feel themselves online as 'real people.' It is one of the dimensions of the overall online learning experience. Through the social presence, lecturers and students feel connected and interact as "real people" through the communication media used. Intimacy and Immediacy are two components of social presence. Both concepts are closely related to each other. Intimacy refers to the feeling of connection in the communicators during an interaction. In contrast, closeness is the psychological distance between the communicators. Both intimacy and immediacy need to be built in online learning by using the existing features, both synchronous and asynchronous ones. In learning, the availability of well-managed learning materials and the high social presence will determine the student's learning success [1-3]. However, the interaction between teachers and students in e-learning is still challenging, that needs special attention.

However, this sudden change in the learning mechanism to be fully online causes lecturers to not be fully prepared with various skills in managing online learning. Predicting the success of online learning is very important from the beginning. If several items of activity are found to be inappropriate or do not support success, improvements can be made right from the start. One technique that can be used for this analysis is by looking at learning activity logs. Some activities support social presence and those that give less support. Understanding them will be the basis for improving activities and predicting learning success. This study seeks to predict the success of online learning based on data logs from student activities. From these logs can be analyzed the level of interaction between lecturers-students and students-students. Several studies have shown that one factor that causes students not to pass online learning is the social participation of lecturers online [4,5]. Students in learning often need to talk about friends and teachers [6].

II. METHODS

A. Learning Environment Settings

The online activities during Covid-19 mitigation were conducted from the third meeting. The subject in online learning is the Early Childhood Education Curriculum at the Early Childhood Education Teacher Training in a private university in Yogyakarta, Indonesia. The participants consist of sixty students. Moodle is used as the learning management system. In the second meeting, the tasks to accomplish were explained to the students so that in the third learning session and so forth, the class immediately went fully online.

The initial assignment required the students to make an analysis (5W+1H) of the development of the early childhood education curriculum and present it in the form of a comparative table. Students made a video presentation and broadcasted the material, then uploaded it to FB and linked it to the assignment menu on the LMS (Learning Management System). At the following meeting, there was a change in the learning scenario. This change was because it was felt that one meeting was not enough to discuss material about the curriculum model. The model is based on the early childhood education approach in the world (five kinds of approaches). This change is one of anticipation due to slow system response to some synchronous activities.

The strategy in managing the learning is group work. One group discussed a curriculum model. This is an adaptation of the Jigsaw cooperative learning model. The students were introduced to the concept of DAP (Developmentally Appropriate Practice). They must prepare the internalization of the concepts and theories. It made the online interaction process run better because the students were ready. Many questions could be discussed, and the lecturer still had enough time to confirm, made rectification of understanding, and provided reinforcement by the end of the discussion. In this case, the students were only able to ask questions if they read.

B. Learning Analytics Procedure

Learning Analytics is defined by [7] as measuring, collecting, analyzing, and presenting data about learners to understand and maximize the learning and learning environment. The learning analytics used the prediction method. This study makes modifications to its phasing. The stages in the prediction are depicted in Figure 1.

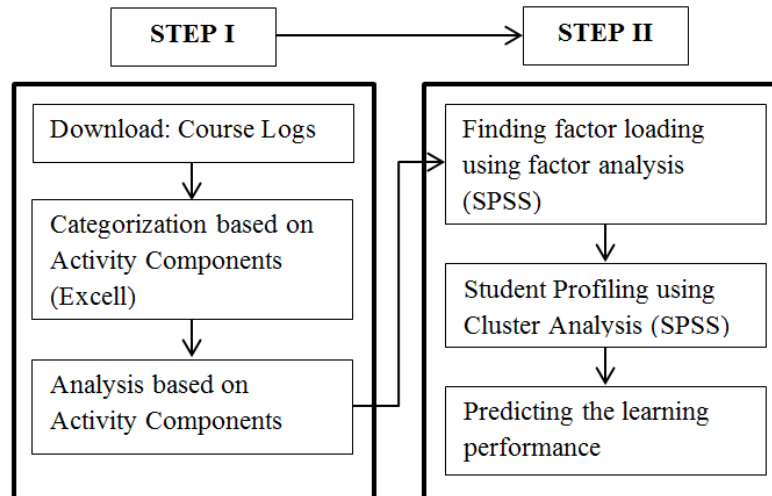


Figure 1. Learning Analytics Process

C. Statistical Techniques

The ex-post facto design approach was implemented in this study. There were three analytical techniques, i.e., descriptive statistics, Factor Analysis, and Cluster Analysis. First, descriptive data were employed for each activity component. Factor Analysis was applied to decide which items gave significance loading to the variable. Further, cluster analysis was applied by transforming data to Z-score, and 3 clusters were selected accordingly. The technique used in this analysis was the K-Means Cluster.

III. RESULTS

A. Report based on activity components

The Logs data taken from Moodle on the Subjects were observed, tabulated based on the Activity Components. A screenshot of the final results of the tabulation is presented in Figure 2. It shows fields consisting of Respondents, Hits, Chats, Forums, Systems, Assignments, Files, File Substitution, LTI, Online Text. Each cell contains the number of activities carried out by the participants during online learning (up to data collection only). The score in Hits (Column B) is the sum of the range of activities (Column C to column K). These data do not provide an overview of the quality of activities compared to other activities. The data only reveal the level of students' activities in online learning. Besides, every hit made by a student does not give an idea of how long they did the action online.

	A	B	C	D	E	F	G	H	I	J	K
1											
2	Respondent	Hits	Chat	Choice	Forum	System	Assignme File	File subm	LTI	Online te	
3	Intentionally blocked	113	17	26	19	51	0	0	0	0	0
4		101	27	12	22	37	0	3	0	0	0
5		45	7	19	5	14	0	0	0	0	0
6		77	10	10	8	27	15	1	2	2	2
7		66	15	8	8	19	8	2	2	2	2
8		63	15	12	0	22	4	5	2	1	2
9		103	16	14	17	36	14	2	2	0	2
10		125	36	11	0	41	25	0	6	0	6
11		106	25	17	5	41	6	9	0	3	0
12		130	24	19	26	27	26	4	2	0	2
13		119	23	13	17	41	12	8	2	1	2
14		126	14	21	22	45	12	4	4	0	4
15		89	13	11	17	32	8	4	2	0	2
16		77	11	20	15	15	12	0	2	0	2

Figure 2. Final Data Extracted from Logs

To see the trends in online activities that were Hits-based, Figure 3 shows the results.

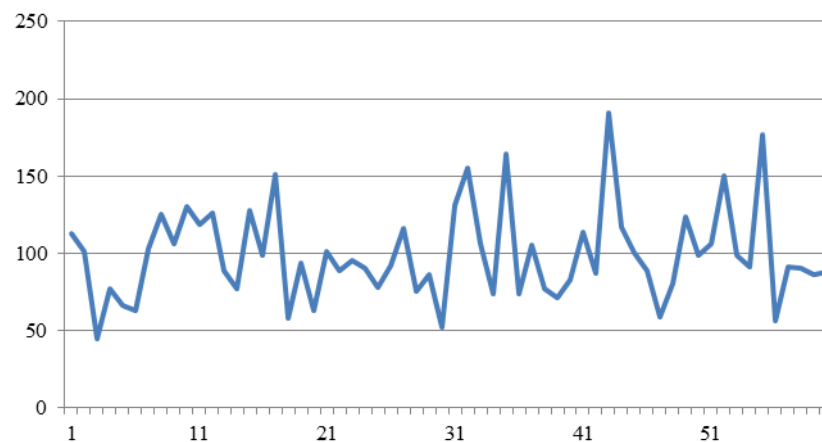


Figure 3. The Posting Number per Student

It can be seen in Figure 3 that there is a wide range (50 to 170 hits) among students in the number of hits during online activities. This figure can be pre-assumption. The level of student hits as one of the determinant factors in learning success, there is a possibility of students who are less successful than the others because of the low number of hits. However, the different levels of activity may result in different effects on the level of learning success. It is essential to explore how the distribution of activity hits is based on the activity component. The results of the analysis are presented in Figure 4.

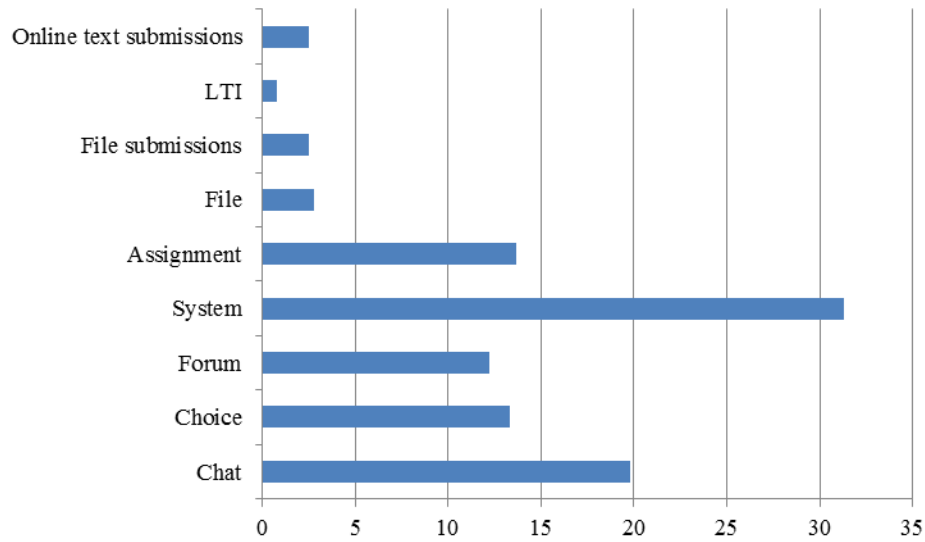


Figure 4. The Posting Number Based on Activity Components

From Figure 4, the four highest activities are Chat, Choice, Assignment, and Forum. The assumption is the System did not provide an overview of the events to get into the LMS. Also, other essential activities have been conducted maximally by students, such as Online text submission, File submission, and File (download). It is a possibility that the low activity was due to the situation where the students were not directly assessed during the learning session. But, there was still enough time for deadlines. The analysis of synchronous and asynchronous activities can be seen in the number of students hits on Chat and Forum activities (See Figure 5).

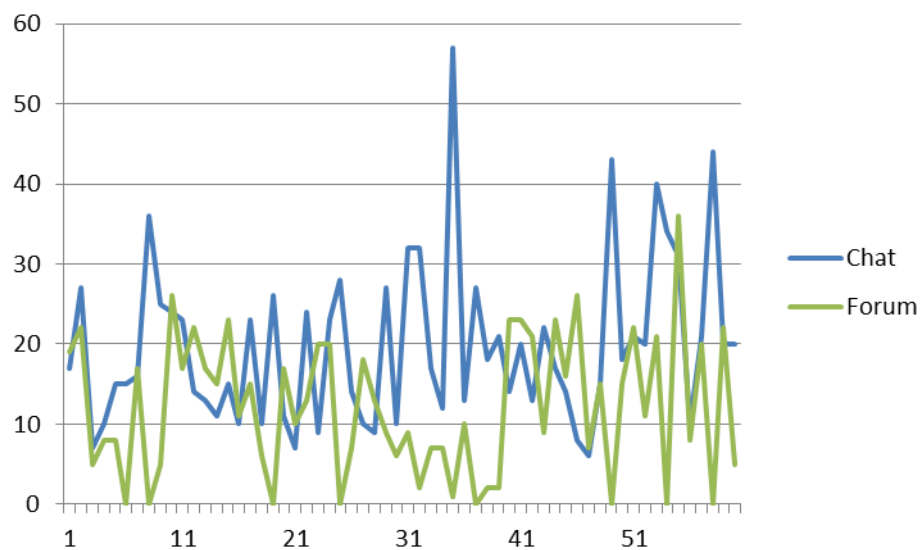


Figure 5. Comparing the Synchronous and Asynchronous Posting Number

Figure 5 shows that there is no consistent tendency among the students in doing synchronous and asynchronous activities. Many students were very active in Chat activities but less intense in Forum activities and vice versa. This phenomenon is seen in the picture on which the Chat line is very rarely in the same position as the Forum line. This is an exciting result for further discussion. Specific analysis of student assignments can be seen in Figure 6. This figure compares the level of task completion in the form of Choice and Assignment.

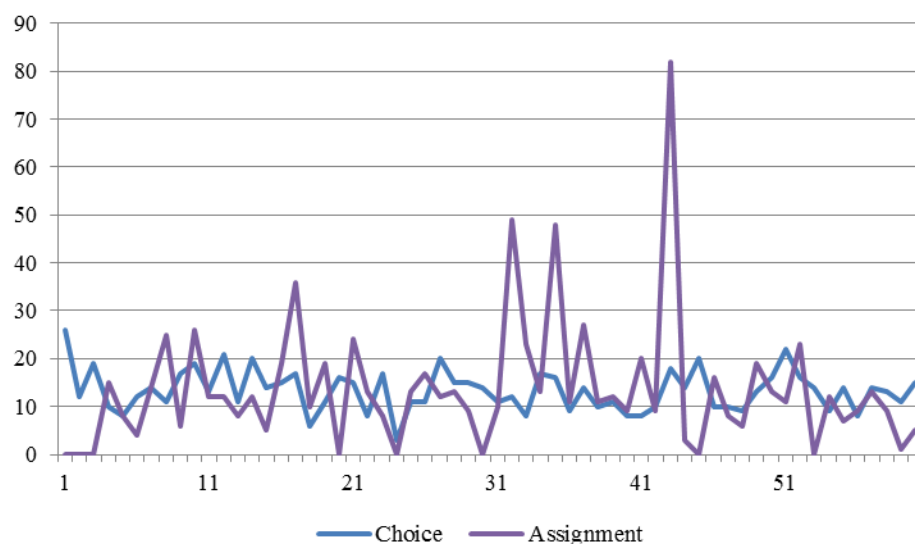


Figure 6. Comparing the Evaluation Type Response

The variety of task completion is ample for this type of Assignment. On the other hand, the accomplishment of the Choice assignment is relatively more uniform. In fact, for individual students, there is a reasonably high activity, especially for the type of Assignment. Further discussion is needed to see whether these findings are related to deadlines and whether the task can be completed multiple times.

B. Descriptive Analysis

The descriptive analysis of the results of tabulation processing (see Figure 1) is depicted in Table 1. This table shows the values for descriptive statistics.

Table 1. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
TOTALHITS	60	45.00	191.00	99.0167	30.26745	.888	.309	.967	.608
Chat	60	6.00	57.00	19.8167	10.29973	1.280	.309	2.035	.608
Choice	60	3.00	26.00	13.3500	4.32895	.386	.309	.326	.608
Forum	60	.00	36.00	12.2000	8.65497	.265	.309	-.636	.608
System	60	14.00	69.00	31.3000	12.63342	.939	.309	.731	.608
Assignment	60	.00	82.00	13.6500	13.62802	2.744	.309	10.704	.608
File	60	.00	13.00	2.7667	3.17494	1.605	.309	2.032	.608
FileSubmission	60	.00	12.00	2.5333	2.07868	1.872	.309	6.242	.608
LT1	60	.00	7.00	.7667	1.45400	2.510	.309	6.639	.608
OnlineTextSubm	60	.00	12.00	2.5333	2.07868	1.872	.309	6.242	.608
Valid N (listwise)	60								

C. Factor Analysis

Extraction value using factor analysis (Principal Component method on Eigenvalue higher than 1) was applied to check the availability of the item as explaining factor to the variable. The results is in the communalities (Table 2).

Table 2. Communalities

	Initial	Extraction
Zscore(Chat)	1.000	.767
Zscore(Choice)	1.000	.797
Zscore(Forum)	1.000	.742
Zscore(System)	1.000	.669
Zscore(Assignment)	1.000	.760
Zscore(File)	1.000	.539
Zscore(FileSubmission)	1.000	.962
Zscore(LT1)	1.000	.702
Zscore(OnlineTextSubm)	1.000	.962

Extraction Method: Principal Component Analysis.

The next review was on how effective factors for grouping items. The Total Variance Explained table as Table 3 used for determining what factors might be formed.

Table 3. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.856	31.731	31.731	2.856	31.731	31.731	2.551	28.340	28.340
2	1.775	19.722	51.453	1.775	19.722	51.453	1.775	19.726	48.066
3	1.260	14.000	65.453	1.260	14.000	65.453	1.294	14.374	62.441
4	1.011	11.229	76.682	1.011	11.229	76.682	1.282	14.241	76.682
5	.693	7.695	84.377						
6	.570	6.332	90.708						
7	.495	5.498	96.206						
8	.341	3.794	100.000						
9	-1.297E-16	-1.442E-15	100.000						

Extraction Method: Principal Component Analysis.

Based on Table 3 in the Component column, shows that nine components can represent the learning activities. By determining the selection on an eigenvalue of more than 1, there are four factors as the best one in grouping items. These results are following the model used in the TR, which includes four indicators. These four factors will explain the variable of 76.682%. Next, the rotation component matrix, as Table 4, is used to select the items related to their factor.

Table 4. Rotated Component Matrix^a

	Component			
	1	2	3	4
Zscore(FileSubmission)	.966	.044	.063	-.156
Zscore(OnlineTextSubm)	.966	.044	.063	-.156
Zscore(Assignment)	.784	.042	.296	.238
Zscore(System)	.081	.797	.003	.166
Zscore(File)	.046	.728	.039	-.071
Zscore(Chat)	.160	.234	.826	-.060
Zscore(Forum)	-.171	.502	-.675	.081
Zscore(Choice)	-.093	.305	.029	.833
Zscore(LT1)	.014	.452	.241	-.663

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

Determination of which variable is part of a particular factor is determined by finding at the most significant correlation value. Table 4 above has been sorted from the most significant value to the smallest per factor; thus, FileSubmission has the most significant correlation with factor 1, i.e., .966, as

well as OnlineTexSubmission: .966, and Assignment: .784. See the red box in Table 4 for the loading factor more than .5. Therefore in the cluster analysis, only 4 components will be applied.

D. Cluster Analysis

Before the cluster analysis was performed, all data of activity components were transformed into the Z-Score. The cluster analysis was performed on the Z-Score by determining 3 clusters according to the possible groupings using the Elbow method. The study was conducted by the K-Means method. The results of this analysis are presented in Table 5 for Distances between Final Cluster Centers. The number of members of each cluster from the analysis results is 2 (Cluster 1), 14 (Cluster 2), and 44 (Cluster 3).

Table 5. Final Cluster Centers

	Cluster		
	1	2	3
Zscore(Chat)	2.39650	.10102	-.14107
Zscore(Assignment)	2.55723	.68085	-.33287
Zscore(OnlineTextSubm)	3.11095	1.04920	-.47524
Zscore(FileSubmission)	3.11095	1.04920	-.47524

The results of this cluster analysis are also presented in Figure 7.

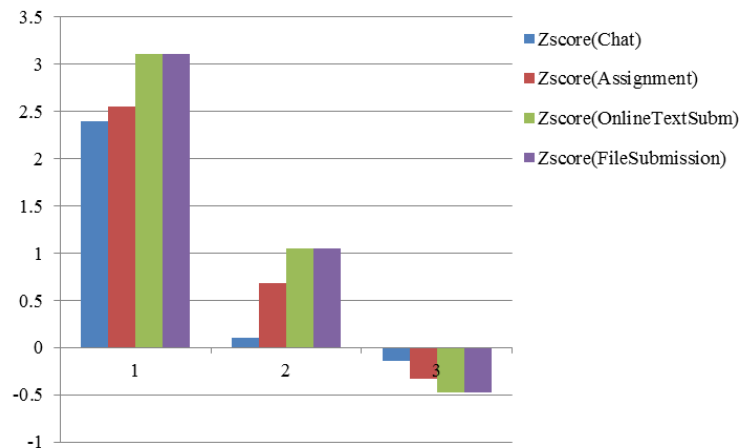


Figure 7. Clustering Result

Based on Figure 7, we can categorize the cluster characteristics as presented by Table 7.

Table 7. Cluster Characteristics

	Chat	Assignment	Online Text Submission	File Submission
Cluster 1	H	H	H	H
Cluster 2	MH	MH	MH	MH
Cluster 3	ML	ML	ML	ML

H= High; MH= Moderate High; ML: Moderate Low

IV. ANALYSIS

Garrison stated a practical educational experience in the computer-mediated community [8,9]. This effectiveness includes cognitive presence, social presence, and teaching presence [10-12]. In many studies also found, online learning has many challenges to build human sense while online. Online learning not only uploads material and assignments in cyberspace but also needs to create compelling interactions compared with classroom learning [4,13,14]. Unlike face-to-face learning, in online education, lecturers cannot quickly or directly provide assistance to students. Otherwise, students can promptly fail to benefit from the learning process [9]. Healthier online communities characterized by mutual trust, respect, and collaborative support exist [15].

Based on the experiences and the learning sessions of each meeting, there are some points to reflect. There are several activities as the driving factors and the factors inhibiting success in online learning. Therefore, solutions can be offered in improving online learning. Each reflection is presented as follows. The factors driving the success of online learning are student involvement in managing learning, the accuracy of the implementation of active student-centered learning strategies, the utilization of a variety of activity menus, and the readiness of teaching materials. Being involved in managing learning, the students build a sense of responsibility for making the decision that they have an exceptional commitment to attend the lessons with comfort and happiness. Involving the students by allowing them to manage their own learning is one of the determinants of student learning success [16,17].

A sense of comfort is an expression of an individual's emotions. A study confirms that emotional involvement plays a significant role in the academic success of students [18,19]. The comfort that determines learning success is a comfort during learning [20,21]. The real pleasure is something that can be built together between the lecturers and students through an effective communication process and openness. This situation would improve social presence. It provided the cohesion to sustain students' participation and focus. It also creates a sense of belonging, supporting freedom of expression. This related to the research finding that social presence positively enhances teaching presence and cognitive presence [22].

There are differences in implementing student-centered active learning strategies in online learning from offline learning. It is crucial to select appropriate learning methods for online learning. Adaptation of student lecturers is needed in dealing with this difference. Learning materials and resources need to be appropriately prepared to support active student-centered learning. The form of active learning by the students, in this case, is the opportunity for students to access and study learning resources before attending the learning session. It is expected that this strategy increases social presence in online learning. The social presence is conducted by giving simple tasks to students. For instant, making a question from the material that has been discussed (problem posing), creating a chart of analysis of certain concepts (summarizing). This activity supports the learning process through interactive discussions. Once there were presentations during online learning using chat sync mode. Emotional presence can affect feelings of closeness and relationships between individuals [23].

Chatting is very much felt at social presence. Still, this activity requires a lot of time and becomes a burden on the internet quota for students. Despite this chat mode, sometimes the level of student activity is also not evenly distributed (see Figure 6). A more detailed search is also shown in Figure 8.

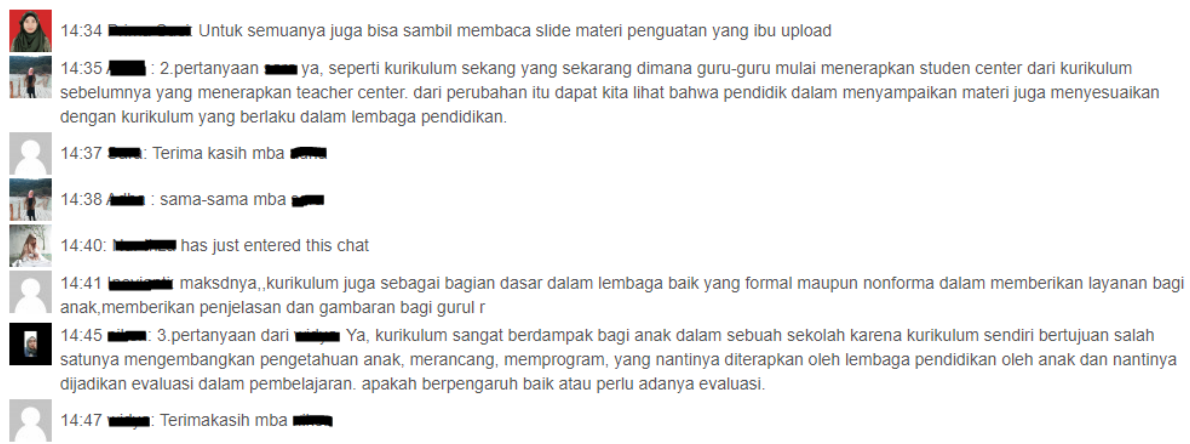


Figure 8. Some of chatting activity on curriculum during mitigation

Figure 8 shows a quite active chatting situation where there were quite a lot of members participating with a quite good post content. However, there are situations where chat activities could not run smoothly due to lousy network problems. This resulted in many students left the chat room (See Figure 9). The problem is that high learning control by the teacher could increase cognitive presence, but it will decrease social presence. It would affect a student's critical thinking skills [24] and student's engagement [25]. The social presence will also positively increase when the teacher builds interaction that encourages attitudes of respect, positive, motivate, punctual, free-flowing, and repetitive [26,27].

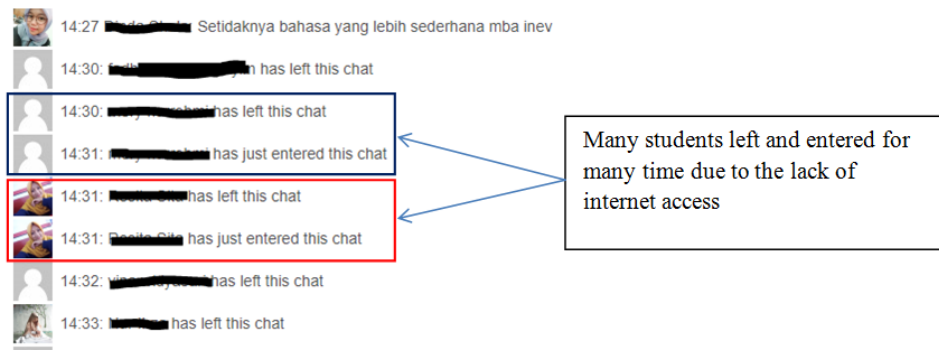


Figure 9. Some Examples of the Unsuccess Chatting Activity

Complaints during this sudden online learning are on the power of bandwidth, which resulted in slow system response (See Figure 9). The ease of use of technology and the excellent connection of the internet network are supporting factors that are part of the technical implementation of online learning. The subsequent impact is that the level of student lecturer interaction becomes less effective. It is the fact that there are obstacles when implementing online learning using Moodle provided by the university. System response that sometimes slowed down makes time run out only for certain activities. This happened when carrying out activities in the chat room. The lecturer and students left and entered the chat rooms. The events became ineffective. Some factors causing failures include infrastructure unpreparedness: availability of internet networks, lack of gadgets for information access [28], low ICT literacy of the teachers [29], the level of social presence in online learning [30], student self-regulation that is not quite good [31,32], and the level of technology readiness of the teachers in online learning [33,34].

The other side occurring when chatting is the communication control that was not easy. Sometimes to review answers or answer questions, posts have piled up on the chat rooms. A more structured discussion was held (See Figure 10), including feedback activities to deal with this situation. The change of discussion issues was controlled by the lecturer, and it was carried out after an issue was discussed. Another form of teacher involvement is to provide feedback on students 'answers to other friends' questions. Therefore feedback from lecturers and students both during learning is important. Feedback in online learning can effectively maximize student involvement, which can accommodate social presence [35]. The other way to increase learning effectiveness is by giving a trigger. It makes students more enthusiastic in the learning interaction. It also will increase social presence intensity. Therefore it will encourage the cognitive presence as well.

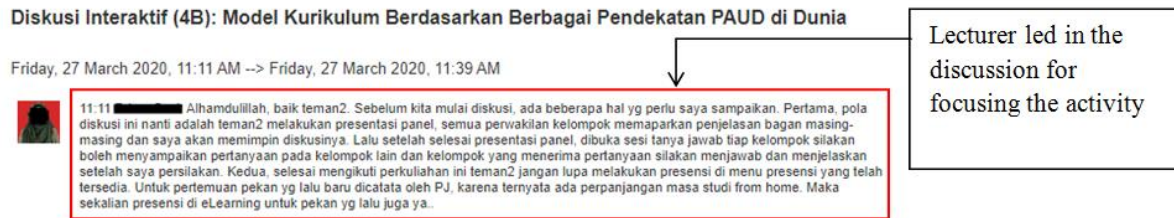


Figure 10. Lecturer Maintained the Discussion Path

Another alternative is to use an asynchronous forum (See Figure 11). By using this forum, it is clearer which part was being answered, and the answer was in a position closed to the question so that it was easy to understand when reread.



Figure 11. More Effective Discussion Scene in the Forum

As the implementation of sudden learning due to this mitigation situation, the lecturers tend to try to be able to learn LMS in a short time. They need to experience trial-error stages in conducting the course at each meeting. Both lecturers and students need to adapt to find the most effective teaching-learning strategies. The full features of the Moodle application enable the selection of complementary features so that learning outcomes are achieved. Thus, weaknesses in learning with one activity menu can be complemented and supported with other activity menus. For example, synchronous chat submission menus, forums, uploads are the most commonly used menus. Each has advantages and disadvantages. Therefore, using a variety of menus can be a direct experience in doing online learning.

Readiness and completeness of teaching materials that meet student learning achievements support the success of the online learning process. In these learning sessions, the content being studied (learning object) still focused on the broadcast material, modules, and journals. So far, the availability of learning objects meets the diversity of materials. Some suggestions for active learning are to provide multi-representation teaching materials in various formats. Thus, teaching materials cannot yet accommodate all student learning styles. Attention to the diverse characteristics of students will be able to increase the success of online learning. Other positive alternative activities during online learning are (1) involving students in managing to learn, (2) upgrading tools to meet user needs, (3) determining appropriate learning strategies suitable with the characteristics of students and online learning systems, (4) preparing a variety of teaching materials that are complete and varied, and (5) making functional internet networks.

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